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CHOICE OF BOTTOMHOLE SCREEN WELLS IN VANKOR FIELD OIL PRODUCTION

Ledkov A.O.
Scientific supervisor: candidate of science, professor SFU Kondrashov P.M.

Siberian Federal University

Vankor field is one of the largest hydrocarbon deposits in Russia, it is of strategic importance for the state. At present, the recoverable reserves are estimated at 520 million tons of oil and 95 billion cubic metre of gas. The field is located in north-eastern part of the West Siberian platform. Main reserves are concentrated in the productive stratum Yak3-7 and Nh3-4, each of which has a gas cap and bottom water. Average effective oil-bearing zones comprise of about 22 m for the bed Yak3-7 and 14 m for the bed Nh3-4. The main producing horizons have a sandy composition, and are confined to the lower cretaceous nizhnehetskoy and yakovlev measure. There are 3 main groups of drill cuttings in sandstone: 1.quartz debris 2. feldspars 3. rock volcanic and sedimentary debris.

Horizontal wells are used in Vankor oil field development and horizontal borehole length is about 1000 m. In order to increase productivity, reduce costs and risk horizontal wells are completed not using a casing in the productive intervals, due to drilling cuttings. There are two type of filtering: oil separation from sand on the surface and inside the hole. Both the first and the second methods for oil separation from oil sand are used in various oil fields. The experience of hydrocarbons recovery shows that rational way of getting rid of sand in the bore-hole filters installation. The main advantages of applying well screens are:

1. Improving the quality of extracting hydrocarbons.
2. Prolongation of downhole equipment operation life by preventing sand and other solid fractions.
3. Reduction of tubing string wear.

According to the data obtained from Rosneft magazine "Scientific-Technical Journal" the screened pipes are used in Vankor oil field wells. Thus it provides for high oil production rate during approximately the first 500 days. But then due to a late gas and water inrush through high permeability well can work with high oil rate production and low gas and water production rate production.

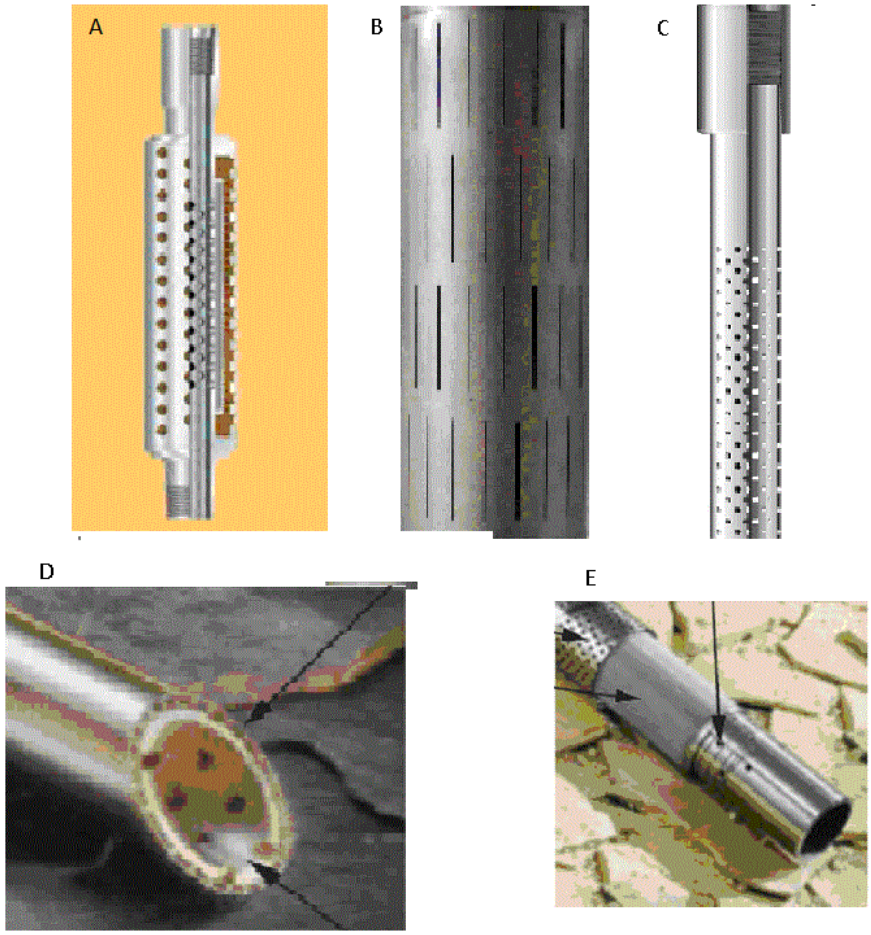
There are currently many types of well screens (fig.1), but the most widely used are frame-rod well screen, ringed well screen and perforated well screen. Design of each well screen requires a separate approach for the accurate calculation of seepage flow to the well.

The main filters parameters determing the size of the passing particles, under the certain circumstance are filter holes size and shape and the geometry of the filter membrane elements. The dimensions of passages depend on the fractional composition of the sand and filter hole shape. According to the theory presented by A.M. Pirverdyanu the best ones are gauze filters which size is 0.25 x 1, 56 mm.

While designing well screen it is necessary to consider the conditions under which it will work, that is abnormal pressure and temperature, corrosive environment, reservoir instability, etc. Under these conditions, the filter must have a high capacity to hold sufficiently small size particles, not being difficult to use, having a long operation life, as well as a low cost. Determining factor in the choice of filter design is the type of reservoir, its homogeneity and permeability.

Slotted screen, due to its all-purpose design, can be used in the faciliting installation of any manufacturers. It has a relatively low initial cost, but it has some shortcomings in the operation. Compared with wire-wrapped gap filters, slotted screen has a relatively small entrance area. Since the slotted filter tubes are usually made from mild steel, then they may be exposed to corrosion and erosion. Filters with horizontal cut slots are able to narrow or expand during the process of capturing by fishing tools while their retrieving from the well, but they are not enough strong in tension. When bending, they can increase or decrease slots width, respectively sides of the arc.

Slotted screen positively works in wells with high content of mechanical impurities, does not allow solid particles to settle on the filter surface, thereby service life is increasing. Due to the special wire section, a partial self-cleaning surface of the filter elements is possible as well as easy cleaning of slotted lattices using backwashing.



A - gravel-packed filter; B - slotted strainer; C – perforated filter;
D – wire – wrapped filter; E – gauze filter.

Figure 1 – Well strainer

Gauze filter is used in wells without casing string. On manufacturing of gauze filter the sieves made of stainless, chemically resistant steel are used. Drainage sieves provide for equalized fluid distribution across the surface of steel.

In world practice of manufacturing filters exists an evident trend of substituting multiple filters designs for frames with a wire coil. Among the wire-wrapped filters it's necessary to distinguish different kinds of filters, in which wire is wound directly onto the

pipe, on the grooved body and so on. Wire-wrapping filter are less subject to corrosion and erosion compared with slotted filters. They have higher bandwidth, but the wire-wrapped filters are more expensive. The filter with horizontal slots are considered to be the most effective filters with horizontal slots, that have low resistance and holes interference effect.

Nowadays gravel-packed filters are widely used in domestic and foreign practice and are considered the most promising and are characterized by the following advantages:

1. High gravel permeability compared to cavity sand reservoir;
2. Unlimited filtering surface and any cavity form can be filled with gravel;
3. Small gradient of hydraulic resistance on the thickness of the filter and the low mud fill intensity of processes;
4. Low resistance of filter frame due to a possible increasing of holes sizes in 6-10 times;
5. Design simplicity, uniform properties along the length and thickness.

A common disadvantage of slotted and suspended gravel filter – reducing well productivity due to impermeable solid between the filter and the borehole wall and complexity of removing filter to the surface.

One of the method of sand-control is using of metal-ceramic filters, which are obtained by powder metallurgy and possess the ability to hold solid particles of any given size. However, filters with a porous structure is subject to mud filling by clay particles during well operation. They can withstand a light (0.8 ... 2.0 MPa), pressure drop, there is no contact between the filter and rock reservoir.

V.A. Tolpaev in the work "Mathematical models of the well screens" proves by mathematical analysis, that open area of screen and the size of the filter is directly proportional to each other and while effect on specific yield. While increasing open area of screen filter strength decreases, so you must choose such open area of screen at which the filter has a large capacity and necessary strength. According to his calculations for frame rod well screens specific yield is approaching maximum values of open area of screen - 50%. Ringed and perforated filters are used if open area of screen is about 20% to 30% and 20% to 25%, respectively. It is recommended to use the filters of punched design. This filter design is characterized by high bandwidth at low open area of screen. Such combination allows for a filter to have necessary strength qualities. Wire-wrapped filters and gauze filters are rapidly destroyed by aggressive reservoir waters. Perforated and gravel-packed filters are considered more reliable. The most effective and promising way to prevent sand production is the creation of gravel-packed filters in the well completion.

As for Vankor field, taking into account the horizontal profile of wells and the overlying rocks, we can select the best types of well screens: perforated filter, slotted strainer and gauze filter. When we place the filter in the horizontal well it is necessary to ensure its stability to collapse under abnormal pressure, integrity of filter shape influence as it affects the quality of the filtering layer. Perforated filters meet these requirements and are used with different improving quality of filtering technologies. In order to apply gauze filters and slotted strainers in such wells it is necessary to use special filters design with protruding "ribs" that are attached to the filter body. In practice, filters of different design performances are used and consist of perforating pipes (holes in the form of slots, tapered, trapezoidal holes) on which wire is wound (different cross-section is possible) and wrapped by metal sieve.